Evaluation of MerCAP™ for Power Plant Mercury Control

Quarterly Technical Progress Report

April 1, 2004 – June 30, 2004

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ABSTRACT

This document summarizes progress on Cooperative Agreement DE-FC26-03NT41993, "Evaluation of MerCAP™ for Power Plant Mercury Control," during the time-period April 1, 2004 through June 30, 2004. The objective of this project is to demonstrate the performance of MerCAP™, a technology that uses a fixed sorbent downstream of wet and dry scrubbers for removing mercury from coal-combustion flue gas. The project is being funded by the U.S. DOE National Energy Technology Laboratory under this Cooperative Agreement. EPRI, Great River Energy, and Southern Company are project co-funders. URS Group is the prime contractor.

The general concept for MerCAP™ is to place fixed structure sorbents into a flue gas stream to adsorb mercury and then, as the sorbent surfaces become saturated, thermally regenerate the sorbent and recover the mercury. One example includes parallel gold-coated plates. Mercury forms an amalgam with the gold and is removed from the flue gas flowing past the plates. The captured mercury can be subsequently sequestered using a carbon canister or cryogenic trap during regeneration.

In this project, URS Group and its team will conduct tests at two host power plants to evaluate gold MerCAP™ performance downstream of a spray dryer-baghouse and wet scrubber over an extended period of flue-gas exposure. The spray dryer site, identified in this proposal as Site 1, is Great River Energy's Stanton Station which burns a ND lignite coal. At this site, an array of gold-coated MerCAP™ plates will be incorporated into the outlet plenum of one compartment (6 MWe) of the Unit 10 baghouse. Site 2, the wet scrubber site, is Southern Company Services' Plant Yates which burns an Eastern bituminous coal. Gold-coated structures will be configured as a mist eliminator and configured downstream of a pilot (1 MWe equivalent) wet scrubber receiving a flue gas slipstream obtained immediately downstream of a full-scale FGD absorber. MerCAP™ will be evaluated for mercury removal during normal boiler operation for periods of six months at both sites.

The ability to repeatedly thermally regenerate exposed MerCAP™ plates is a critical component to the overall economics of the technology. Therefore, during the longer-term tests, small-scale tests will be conducted to evaluate the mercury removal effectiveness at both sites following repeated regeneration cycles. Tests will be conducted using a 40-acfm slipstream probe device ("Mini-MerCAP™ probe"). Gold-coated substrates from the same production batch used for the MerCAP™ arrays in the larger longer-term tests will be used in the Mini-MerCAP™ probe. MerCAP™ technology has been successfully tested in small-scale units installed at the proposed test sites. Results of the study will verify this performance at a larger scale and over a longer period of gas exposure and will provide data required for assessing the feasibility and costs of a full-scale MerCAP™ application.

During this period, efforts included completion of the design and start of fabrication and on-site installation of the full-compartment test components. A series of intensive tests were conducted utilizing the mini-MerCAP™ probe system to identify plant operating conditions that can result in both optimum and detrimental performance of the MerCAP™ system. Initial baseline mercury measurements were also made at Stanton Station during this reporting period.

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INTRODUCTION

This document is the quarterly Technical Progress Report for the project "Evaluation of MerCAP™ for Power Plant Mercury Control," for the time-period April 1, 2004 through June 30, 2004. The objective of this project is to demonstrate the performance of MerCAP™, a technology that uses a fixed sorbent downstream of wet and dry scrubbers for removing mercury from coal-combustion flue gas. The project is being funded by the U.S. DOE National Energy Technology Laboratory under this Cooperative Agreement. EPRI, Great River Energy, and Southern Company are project co-funders. URS Group is the prime contractor.

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Great River Energy is providing co-funding and technical support to this project and is providing Stanton Station Unit 10 as a host site. Unit 10 fires North Dakota Lignite and is configured with a spray dryer as a dry FGD system, with a downstream baghouse for particulate control. At this site, an array of gold-coated MerCAP™ plates will be incorporated into the outlet plenum of one compartment (6 MWe) of the Unit 10 baghouse.

Southern Company is also providing co-funding and technical input to this project and its subsidiary, Georgia Power, is providing its Plant Yates as a host site for testing. Plant Yates Unit 1 fires a low-sulfur bituminous coal and is configured with a small-sized ESP for particulate control, and a downstream CT-121 Jet Bubbler Reactor (JBR) wet FGD system**.** Gold-coated structures will be configured as a mist eliminator and configured downstream of a pilot (1 MWe equivalent) wet scrubber receiving a flue gas slipstream obtained immediately downstream of a full-scale FGD absorber.

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This report describes the activities carried out for this program during the project-reporting period April 1 through June 30, 2004. The remainder of this report is divided into four sections: an Executive Summary followed by a section that describes Experimental procedures, then sections for Results and Discussion, and Conclusions.

EXECUTIVE SUMMARY

Summary of Progress

The current reporting period, April 1, 2004 through June 30, 2004, is the second full technical progress reporting period for the project. Efforts during the current period focused on tasks associated with testing on the mini-MerCAP probe and initial installation of the large-scale unit at Stanton. Specific activities included parametric regeneration tests on the mini-MerCAP unit, baseline mercury measurements, procurement of the frames and installation of the ductwork for the large-scale installation, modification of the baghouse at Stanton to accommodate the frames, testing ports and instrumentation, and procurement and initial electroplating of gold screens for the large installation. Table 1 lists the planned and completed milestones for the first year of this project. A summary of each activity carried out during this reporting period is provided below.

Table 1. Schedule for Year 1 Milestones for this Test Program.

Milestone	Description	Planned Completion	Actual Start/ Completion
1	Submit Hz. Subs. Plan	Q1	Q1/Q1
2	Submit Test Plan	Q1	Q1/Q1
3	Frame Installation/Baseline Monitoring Site 1	Q1	Q1/Q2
4	Site 1 Gold Installation, Intensive Testing	Q1	Q1/Q3
5	Start of Long Term Testing, Site 1	Q3	Q3
6	End of Long Term Site 1, Gas Char Tests	Q3	
7	Site 1 Review/ Site 2 Planning Meeting	Q3	
8	Frame Installation/Baseline Monitoring Site 2	Q4	

A series of intensive tests utilizing the EPRI mini-MerCAP™ probes were initiated and completed during the second quarter of 2004. These tests were configured to determine effects of plant scrubber operation on the removal performance and longevity of the fixed structure sorbents. Scrubber operating parameters, specifically lime slurry feed-rate and approach temperature were varied to determine operational windows that would result in the best performance of the MerCAP™ system. These tests were conducted using the EPRI mini-MerCAP™ probes due to the reduced quantity of substrate required and ability to independently control temperatures. Evaluations involved installation of gold substrates and continual monitoring for 24-48 hour periods where plant scrubber conditions were held at requested levels. Several tests were conducted where the substrates were exposed to minimally scrubbed flue gas and degradation was observed. These substrates were removed from service, cleaned and regenerated using a chemical wash and returned to service to confirm if chemical cleaning would restore them to function. The chemical washes were analyzed off-site in an attempt to determine the key flue-gas constituents that cause degradation. During this testing effort, the possibility of regeneration of the gold substrates with a chemical wash was identified as a feasible alternate to

the thermal regeneration techniques for the extraction of the captured mercury from the substrates.

The final design for the full-compartment test components was completed. Specifically, duct sections that house the MerCAP^{TM} screens and support frames were procured and shipped to the site. The screen substrates were procured and electroplating of the gold coatings was started. The host site has initiated modifications to the baghouse compartment to allow for installation and support of the full-scale system and has installed additional sampling ports to provide for instrumentation and sampling probe access at the inlet and outlet of the MerCAP^{TM} system. Figure 1 is a photo showing two of the four duct support sections installed in the baghouse compartment.

Figure 1. MerCAP^{TM} Duct Support Structure in Unit 10 Baghouse Compartment

The materials specified for the wire support frame structure were upgraded to facilitate chemically regenerating or washing the assemblies. The support frames had been designed for thermal regeneration capability but material substitutions were required to allow for the possibility of chemical regeneration.

Sub-Contracts

No sub-contracts were awarded during this reporting period.

Task Activity Summary

Table 3 lists the current activity status of the primary tasks for this program. The Stanton MerCAP™ testing had been delayed in the first quarter of 2004 due to operation issues at the host site.

Table 3. Project Activity Status.

Task Number	Description	Planned % Completion	Actual % Completion
1	Project Planning	50%	50%
2	Stanton MerCAP™ Testing	60%	50%
3	Yates MerCAP™ Testing	0%	0%
4	Economic Analysis	0%	0%
5	Project Management & Reporting	20%	20%

Problems Encountered

No technical problems were encountered during this reporting period.

Plans for Next Reporting Period

The next reporting period covers the time-period July 1 through September 30, 2004. During this quarter, final checkout of the full-compartment fixture will be completed and instrumentation checkout performed. The intensive test measurements conducted on the mini-MerCAP^{TM} probes will be repeated on the full-compartment test fixture followed by an extended period test run. These measurements will be conducted utilizing semi-continuous emissions monitors (SCEM) and verified with Ontario Hydro method (OH) runs during baseline and MerCAP^{TM} evaluations.

Thermal regeneration tests utilizing the mini-MerCAP^{TM} probes will be initiated and the feasibility and technical requirements of the chemical regeneration system will be further examined.

During the initial installation of the MerCap™ system, a period of intensive mercury measurements will be made across the unit using SCEMs. These will last approximately one week, and will determine the initial performance of the MerCAP™ system.

Prospects for Future Progress

During the subsequent reporting period (July 1 through September 30, 2004), long term testing is planned for the MerCAP™ installation at Stanton. Work activities will include periodic mercury measurements across the large-scale unit, as well as mercury measurements made across the mini-MerCAP™ probes with further attempts at regeneration.

EXPERIMENTAL

The series of intensive tests conducted with the mini-MerCAP^{TM} probes were performed to identify plant scrubber operating conditions that resulted in optimum performance of the MerCAP^{TM} substrates. These tests were conducted to establish a set of operational guidelines for the plant during start-up and extended full-compartment test to minimize the risk of degradation to the gold substrates.

RESULTS AND DISCUSSION

During baseline evaluation, the total vapor-phase mercury concentration ranged from 7.5 to 13 $\mu g/Nm^3$ for all sampled locations. The baseline flue gas contained little (< 10%) oxidized mercury. Native removal across the SD/BH configuration was less than 10% during baseline.

Mercury removal results for the gold substrate operated at a 1 inch plate spacing and a face velocity of 40 feet per second was between 55% and 65%. Scrubber conditions when lime slurry feed rates were lower than 15 gallons per minute (GPM) to the reactor vessel resulted in early degradation and mercury capture performance of the gold substrates. Elevated scrubber outlet temperatures (greater than 225 ^{o}F) even at high slurry feed rates resulted in early degradation of the substrates.

CONCLUSION

A set of plant scrubber operating parameters based on minimum slurry feed-rates of 15 GPM and outlet scrubber temperature of a maximum of 210 ^{o}F have been determined to be the desirable operating conditions when the full-compartment test is initiated. The intensive testing effort will be repeated on the full-compartment fixture at these conditions.

REFERENCES

No references.